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Managing the Complexities of English Language Teaching in Engineering

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Abstract

In this 21st century, engineering employers seek professional engineers who have excellent scientific knowledge and are able to demonstrate good communication and problem solving skills. With this focus on job demands, engineering education has been restructured, balancing the emphasis between scientific knowledge and soft skills. This shift in focus has not only affected the teaching and learning in engineering education, but also English Language (EL) educators who are involved in teaching non-technical components within an engineering education curriculum.

This shift in focus has raised the demand for ESP which include teaching communication skills in English language discourse used in engineering, and teaching problem solving skills in English language teaching. With this demand, challenges are inevitable among EL educators who are generally prepared for teaching English for generic purposes in school settings and who bring with them pedagogical knowledge and beliefs in English language teaching, as well as identities they have developed from their previous to their new workplace. This shift also raises questions about the ways in which English language teaching is positioned, the role of English language courses within an engineering-specific context and the implications of this positioning on the design of the English language courses.

The main aim of this study was to investigate how EL educators managed the complexities in teaching English at one technical university in Malaysia. In addressing the research questions, a case study design was developed to highlight the complexities within that context and the ways in which EL educators managed these complexities. The data for this study were collected through qualitative and quantitative methods to unpack the complex process of teaching English for engineering which included teaching problem solving and communication skills. These methods obtained insights into the ways in which EL educators conceptualised English language teaching, positioned themselves and framed their teaching in an engineering context. The quantitative data were collected through a questionnaire involving 12 EL educators. The data from the questionnaire were used to profile the EL educators at the English Language Department of this university. Based on the profiling, four EL educators teaching undergraduate engineering students were selected for the main study. The qualitative data were collected through document study, individual semi-structured interviews, classroom observations, video recording of classroom observations and stimulated recall protocols.

This study found that there were disconnections between English language teaching and the engineering discipline at this university. These disconnections were due to the dissemination process of the engineering accreditation requirements whereby these requirements went through

multiple layers of interpretation, adaptation and translation before they reached the EL educators, causing ambiguities in positioning English language teaching and misalignments in the role of the English language courses within the engineering academic curriculum. As a result, tensions occurred in determining the emphasis of English language teaching.

The ambiguities in positioning English language teaching and the misalignments of the English language courses presented the EL educators with challenges in managing their pedagogies and framing their teaching within the context of an engineering university. The study found that the strategies that the EL educators exercised in their agency resulted from the interplay between how they positioned English language teaching and the professional identities they developed in their university context. The demand for ESP required these EL educators to teach beyond their expertise, creating challenges for them to establish their professional identities. Complexities emerged when English language teaching involved integration among English language, communication skills, engineering knowledge, and problem solving skills.

This study contributed to the field of English language teaching, specifically to English for Specific Purposes (ESP) by providing knowledge and understanding of the complexities of teaching English for the engineering discipline in higher education. It also contributed to research on professional identities by highlighting the tensions, struggles and negotiations that EL educators faced in positioning themselves within this context to determine their professional identities. The findings of this study deepen our knowledge and understanding of professional identities and agency among EL educators in the Malaysian context, particularly in the discipline-specific context of engineering.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Keywords

English language teaching, English for specific purposes, professional identities, professional agency, ESL educators, English for engineering.

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List of Abbreviations

ABET	Accreditation Board for Engineering and Technology
BEM	Board of Engineers Malaysia
CLO	Course learning outcomes
EAC	Engineering Accrediation Council
EAM	Engineering Accreditation Manual
EFL	English as a foreign language
ELT	English language teaching
EL	English language
EMI	English as medium of instruction
ESL	English as a second language
MUET	Malaysian University English Test
MQA	Malaysian Qualifications Agency
MQF	Malaysian Qualifications Framework
OBE	Outcome-based education
OBA	Outcome-based approaches
PBA	Problem solving approaches
PBL	Problem-based learning
PEO	Programme educational outcomes
PLO	Programme learning outcomes

Chapter 1 Introduction

This study investigated the experiences of EL educators in managing the complexities of teaching English within the discipline of engineering at one technical university in Malaysia. This chapter provides the background to the study by first exploring English language teaching for specific purposes. Next, the chapter discusses the changing job market demands, particularly in engineering industries, and the impacts of these changes on engineering accreditation requirements and engineering education. The discussion of the impacts of the changing job market demands in engineering industries provides an understanding of how these changes create pressure on English language teaching within the context of engineering disciplines.

This introductory chapter, therefore, establishes the focus of the investigations and the key questions that this study sought to address and the significant contribution that this study makes to the field of English language teaching in engineering in higher education. The chapter concludes by outlining the structure of this thesis.

1.1 English Language Teaching for Specific Purposes

Globalisation has elevated the need for English language as the medium of global interactions in various industries such as in business and science. Within these contexts, professionals are involved in various types of communication including writing letters and emails, telephone and face to face discussions with individuals locally and overseas. Given these activities, employers require their employees to be able to interact in English within the context of the discipline they work in. Thus, English language teaching in higher education contexts needs to provide a language learning environment which reflects language use in workplace contexts. This calls for English language teaching to change its focus from teaching grammatical and linguistic aspects to teaching English for specific purposes and for specific disciplines (Bhatia, 2007; Basturkmen, 2010).

The main aim of ESP courses is to develop learners' communicative competence in English within a specific discipline or professional area (Alexander, 2013; Hyland, 2003, 2007). With the need for a future workforce to be able to communicate within a specific discipline, ESP courses are expected to provide specialised English language discourses for specific disciplines. In other words, these courses provide opportunities for students to learn English in meaningful contexts, where the focus is more on vocabulary and language contexts rather than on grammar and language structures. Thus, English language teaching within such a discipline-based context includes teaching

communication skills and contents of a discipline as well as the language itself. The multifaceted nature of teaching English for specific purposes creates challenging roles for English language (EL) educators to play in equipping the future workforce with exceptional English language abilities and communication skills within a particular discipline that these EL educators may not be expert in.

In addressing the demand for English in various industries, English language teaching for specific purposes has been growing in many non-English speaking countries such as Japan, Taiwan and Nigeria, since the 1990's (Hou, 2013; Shi, 2013; Umera-Okeke & Okeke, 2014). Continuous research has been conducted to determine the language needs of various industries and to what extent ESP programmes in non-English speaking countries have addressed English for global interactions in the workplace. Malaysia is an example of how this shift from a linguistics focus to a language in content discipline focus is taking place.

1.1.1 English for specific purposes in the Malaysian context

Teaching English for Specific Purposes (ESP) has been a trend in English language teaching in higher education in Malaysia since the 1990s (Abdullah, 2001). For ESP to be effective, students are required to have a good command of English to enable them to learn the specialised language (Evans & Morrison, 2011). In science and technical fields such as engineering, however, it was found that Malaysian undergraduates have limited proficiency level in English, making it challenging for English language teaching to be contextualised into engineering fields (Musa, 2002; Rafee, Mustafa, Shahabuddin, Razali, & Hassan, 2012; Sidhu & Kaur, 2011). In teaching ESP, the educators are generally of English as a second language (ESL) background (Mustapha & Yahya, 2013). These educators are well-equipped with linguistic knowledge and the pedagogies for teaching the language. However, they may lack understanding about language in a workplace or a discipline. Thus, the concept of ESP may not be well understood by them.

In addition, English language educators need to be informed about the language demands of specific disciplines, for example in engineering industries. However, they may not come from engineering backgrounds and thus, may not understand their students' language needs for engineering effectively. With limited understanding of the nature of ESP, as well as knowledge about the language demands in engineering, EL educators may perceive their role only as language educators (Tan, 2011). As a result, the abilities to interact in English within a particular discipline or in a workplace may be problematic.

1.2 The Changing Job Market Demands in Engineering Industries

In the 21st century, the engineering profession demands excellent scientific knowledge and soft skills such as communication and problem solving to cope effectively with the work demands in their fields. This means that, employers no longer seek candidates who only display high academic achievements. Instead, they seek candidates who are able to apply knowledge and demonstrate skills relevant for a workplace in a particular field. Communicating clearly and accurately, and working effectively as a team are crucial in today's competitive and challenging engineering industries. Having strong communication skills is important to build trust among team members and is a great advantage in securing employment (Zaugg & Davies, 2013). In addition, there is also a great demand for future engineers to demonstrate abilities to solve problems to secure employment in engineering fields (Yusoff, Omar, Zaharim, Mohamed, & Muhamad, 2012; Talbot et al., 2013; Varwandkar & Deshmukh, 2013). For example, in one survey conducted with employers in the engineering industry in the USA, it was found that 60% of employers ranked communication as the most essential skill while 55% ranked problem solving as the second most essential skill (Nicometo, Anderson, Nathans-Kelly, Courter, & McGlamery, 2010).

English has, undeniably, been acknowledged as the global language for communication in the engineering industry (Riemer, 2007). Thus, the increasing use of English as the medium of instruction and interaction at tertiary level in Malaysia has been inevitable. In Malaysia, English maintains second language status and in higher education English is the medium of instruction (EMI) for teaching and learning in science and technology courses, including engineering. Consequently, efforts towards developing communicative abilities of future engineers are not only focused on teaching communication skills but also on teaching the English language.

The need for problem solving skills in engineering is also critical. These skills are not only important for engineers to function effectively in the workplace, but also to cope with unpredictable circumstances throughout their careers (Heylen, Smet, Buelens, & Vander Sloten, 2007; Mourtos, Okamoto, & Rhee, 2004b; Tong, 2003; Wye & Lim, 2009). Despite efforts to develop these skills, the engineering industry remains dissatisfied with the abilities engineering graduates demonstrate in this area (Varwandkar & Deshmukh, 2013). Furthermore, studies have highlighted that there are deficiencies in engineering graduates' communication and problem solving skills (CBI The Voice of Business, 2012; Male, Bush, & Chapman, 2010).

The situation in Malaysia reflects a change in job demands and the impact of this on engineering education is worldwide (ABET, 2007, 2010b; Bradley, 2011; Engineering Accreditation Council, 2007). The increasing need for communication (in English) and problem

solving skills in the engineering field has led engineering accreditation criteria both in Malaysia and overseas to be revised to support the development of communication and problem solving skills (ABET, 2007, 2010b; Bradley, 2010; Engineering Accreditation Council, 2007). As engineering programmes need to comply with these criteria to be accredited, these accreditation criteria impact greatly on the development of engineering education.

1.2.1 The impact on engineering accreditation requirements

Currently, engineering programmes in many countries are required to undergo accreditation processes to ensure that the programmes offered by universities and the engineering graduates produced meet the expectations of engineering professional bodies (Prados, Peterson, & Lattuca, 2005). Furthermore, engineering graduates can only practice engineering if they have achieved Chartered Engineer status (Powell, Bagilhole, Dainty, & Neale, 2004). This can only be achieved if engineering graduates have obtained an engineering degree from an accredited engineering programme.

In the United States, the agency responsible for the accreditation process is the Accreditation Board for Engineering and Technology (ABET). In 1997, ABET developed the Engineering Criteria 2000 (EC2000) to address industrial demands for employability skills which included communication and problem solving skills (ABET, 2010b). The EC2000 described the graduate outcomes that engineering students need to achieve at the end of an engineering programme. These graduate outcomes are presented in Table 1-1 and discussed later in this section.

Accreditation for engineering programmes worldwide is largely influenced by ABET's procedure and guidelines (Patil & Codner, 2007). The ABET is also the consultant for the Washington Accord which is an international agreement among participating accreditation bodies responsible for accrediting engineering degree programmes (ABET, 2010a). Any engineering student who graduates from a degree programme which has been accredited by any of the signatory bodies of Washington Accord will be recognised by engineering bodies of other countries as having met the requirements for entry to the engineering profession (International Engineering Alliance, no date). The Washington Accord was founded in 1989 with signatory bodies from 6 countries, comprising the United States, Canada, the United Kingdom, Australia, New Zealand and Ireland. Today, Malaysia has earned its place as a signatory body of Washington Accord through its engineering body, the Board of Engineers Malaysia (BEM). With the adoption of EC2000, engineering programmes in many countries were restructured to comply with these criteria. As a member of the Washington Accord, the Board of Engineers Malaysia (BEM) reviewed its accreditation guidelines and criteria to align with the EC2000 (Aziz et al., 2006). As a result, 10

engineering graduate programme outcomes were developed (see Table 1-1). These outcomes became the basis for developing and designing engineering curriculum in Malaysia.

Table 1-1: *The Graduate Outcomes by ABET and BEM*

Accreditation Board for Engineering and Technology (ABET), USA : Graduate Outcomes	**Board of Engineers Malaysia (BEM): Programme Outcomes**
a) Ability to apply knowledge of mathematics, science and engineering.	a) Ability to acquire and apply knowledge of science and engineering fundamentals.
b) Ability to design and conduct experiments, as well as to analyse and interpret data.	b) Acquired in-depth technical competence in a specific engineering discipline.
c) Ability to design a system, component, or process to meet desired needs.	c) Ability to undertake problem identification, formulation and solution.
d) An ability to function on multi-disciplinary teams.	d) Ability to utilise systems approach to design and evaluate operational performance.
e) Ability to identify, formulate and solve engineering problems.	e) Understanding of the principles of design for sustainable development.
f) Understanding of professional and ethical responsibility.	f) Understanding of professional and ethical responsibilities and commitment to them.
g) Ability to communicate effectively.	g) Ability to communicate effectively, not only with engineers but also with the community at large.
h) Broad education necessary to understand the impact of engineering solutions in a global and social context.	h) Ability to function effectively as an individual and in a group with the capacity to be a leader or manager.
i) Recognition of the need for, and ability to engage in life-long learning.	i) Understanding of the social, cultural, global and environmental responsibilities of a professional engineer.
j) Knowledge of contemporary issues.	j) Recognising the need to undertake life-long learning, and possessing/acquiring the capacity to do so.
k) Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.	

In Table 1-1, the column on the left shows the EC2000, the graduate outcomes of ABET. The first three outcomes are related to the acquisition and application of engineering knowledge while the remaining outcomes are related to the acquisition of soft skills such as problem solving skills, professional ethics, understanding of global and social issues, and life-long learning, as well as hard skills such as techniques, skills and engineering tools. The EC2000 requires a balance among knowledge acquisition, knowledge application, hard skills and soft skills, with the emphasis on soft skills. The right column shows the BEM programme outcomes. Outcomes *a* and *d* are related to acquisition and application of scientific knowledge and engineering fundamentals while outcome *b* is related to technical skills (hard skills). The remaining outcomes are related to soft skills. Similar to ABET graduate outcomes, the outcomes developed by BEM indicate a balance

among knowledge acquisition, knowledge application, hard skills and soft skills with more emphasis on the soft skills.

Based on the descriptions on BEM outcomes above, the outcomes that are most relevant to English language teaching (ELT) are BEM *c, g, h* and *j*. Outcome *c* is related to problem solving skills, outcome *g* is related to communication skills within engineering fields, outcome *h* is about working effectively as an individual and as a team and outcome *j* is about a lifelong learning. These outcomes suggest that English language teaching needs to provide a language learning environment which develops team work abilities and the skills to communicate effectively among team members in engineering fields. Additionally, English language teaching also needs to consider developing problem solving skills among engineering students. These kinds of soft skills are not traditionally the focus of English language teaching in higher education. This highlights the new and challenging roles that English language teaching needs to play when equipping engineering students for the future workforce in engineering fields.

1.2.2 The impact on engineering education

The adoption of the EC2000 has prompted universities in the United States to restructure engineering education and reconstruct the engineering academic curriculum to support the achievement of graduate outcomes (McCowen & Knapper, 2002; Prados et al., 2005). While the focus on fundamentals of engineering has not decreased as a result of this process, the changes to the content courses provided opportunities for engineering students to learn the engineering fundamentals in context. In addition, the adoption of EC2000 led to an increase in focus on communication skills and problem solving skills in engineering education in higher education institutions.

Similarly in Malaysia, where the quality of engineers and engineering education is monitored by the Board of Engineers Malaysia (BEM), the change in job demands and the adoption of EC2000 in the United States triggered BEM to redevelop its requirements and criteria for accreditation. These requirements and criteria shifted an education system which focused largely on acquisition of engineering fundamentals, to an education system which balanced the acquisition of knowledge with the development of soft skills (Aziz, Noor, Ali, & Jaafar, 2006; Hashim & Din, 2009). As a result of this shift, teaching and learning in engineering education started to emphasise the development of soft skills including communication and problem solving skills (Hashim & Din, 2009). The revised accreditation criteria therefore not only affected engineering lecturers and their courses but also the EL educators who are required to teach these skills and the English language courses they developed.

1.2.3 The expectations of English language teaching in engineering disciplines

Responding to the demands of job markets in engineering industries and the revised requirements in engineering accreditation have raised challenges in developing English language courses for engineering programmes. English language teaching in this context needs to cater for the needs of engineering students who require a higher and more specific level of English language abilities than general effective communication skills. As such, English language teaching is not only required to focus on the enhancement of students' mastery of the English language, but also to support the development of communication skills for the engineering discipline. This requires English language (EL) educators to have knowledge of engineering so that they can appropriately address students' English language abilities and communication skills in an engineering context (Mackiewicz, 2004) which adds to the complexity of their roles.

Another challenge that arises is to determine the type of English language courses which can most effectively support the development of English language abilities and communication skills for engineering. The design of the English language courses should be domain-specific to motivate students to participate actively in the learning process, and to see the relevance of these courses in their engineering programmes (Baik & Greig, 2009; Kirkgöz, 2009). This requires EL educators to be familiar with engineering programmes.

Studies of English for Specific Purposes (ESP) have acknowledged the existing complexities in meeting the needs of students from various academic disciplines in English language teaching (see Bhatia, 2007; Medrea & Rus, 2012; Popescu, 2012). With the revised engineering accreditation criteria, the English language educators not only need to be familiar with communication in English, but also English for engineering contexts and the kinds of problems engineers have to solve.

1.3 Statement of the Problem

English language needs in engineering are reported to be different from other disciplines (Mackiewicz, 2004). In response to the revised engineering accreditation criteria, EL educators involved in teaching English to engineering students face complex challenges in teaching English language in ways that support the development of communication skills in English and in engineering. In this context, EL educators need knowledge about engineering to enable them to teach English and communication skills within an engineering context. Furthermore, EL educators also need to develop students' problem solving skills, requiring them to have both the knowledge of English language discourses used in engineering and also conceptual understanding and knowledge

of teaching problem solving skills. However, there is limited research that has focused on how EL educators manage these challenges in the Malaysian context. Understanding the challenges EL educators face and how they manage them could shed light on English language teaching for a specific discipline, particularly in engineering fields in ways that may help EL educators to teach ESP.

1.4 Aims of the Study

The aim of this study was to investigate how EL educators managed the complexities in teaching English within a discipline-specific context, in this case engineering. The need to develop communication skills in English for engineering raises questions about the ways in which English language courses are positioned within an engineering-specific context and the implications of this positioning for the nature of the English language courses. Given that the needs of engineering students in learning English for Engineering differ from other disciplines, this study investigated how EL educators perceive, teach, reflect on and manage English language teaching in engineering. In order to unpack these complexities, this study addressed the following research questions:

1. How is English language teaching positioned in engineering education?
2. What are the complexities of English language teaching in engineering?
3. How do EL educators manage the complexities of English language teaching in engineering?

1.5 Significance of the Study

This study contributes to the field of English for specific purposes, particularly within Malaysian contexts where EL educators are generally trained as ESL educators to teach in schools. The findings of this study provide knowledge and understanding of the complexities of teaching English language for the engineering discipline in higher education. The study also contributes to research on English language teaching in Malaysia by highlighting the tensions, struggles and negotiations that EL educators faced to teach effectively within this context.

1.6 Structure of the Thesis

This chapter established the context of the study by exploring the nature of English language teaching in higher education, focusing on English for Specific Purposes (ESP) and English for Academic Purposes (EAP). The chapter also discussed the job market demands in engineering and the impact that engineering accreditation has had on engineering education and English language

teaching. In addition, the problem statement, the research questions and the significance of the study were also discussed.

Chapter 2 explores existing research in English language teaching in higher education, particularly in the context of English for Specific Purposes (ESP) and English for Academic Purposes (EAP) in various disciplines. This chapter also reviews engineering education, tracing the shift in focus from knowledge-based to outcome-based education. The final section in this chapter discusses the conceptual framework used to provide a lens to investigate the research questions.

Chapter 3 offers a rationale of the research design of this study. In particular, this chapter outlines the research design, method, data collection and data analysis procedures for this study.

Chapter 4 discusses the analysis of the documents related to the engineering accreditation requirements and procedures, the university objectives, the engineering programme descriptions, and the syllabus and course content of the English language courses. This chapter presents the findings on the positioning of the English language courses within the engineering academic curriculum and highlights the competing priorities among the stakeholders, namely, engineering authorities, the university, the engineering faculties, the students and the EL educators. This chapter also raises the issue of limited opportunities for the EL educators to respond to these requirements and to exercise agency within their institutional context.

Chapter 5 profiles the EL educators at the English Language Department at this university. The profiling provides a snapshot of how the EL educators conceptualise English language teaching within their institutional context and how they perceived the engineering accreditation requirements as well as their beliefs and practices in teaching English at this university.

Chapter 6 presents the findings on how the EL educators position English language teaching, and how they manage their beliefs and teaching and learning at this university which require them to exercise their agency.

Chapter 7 presents EL educators' practices in teaching English for engineering. The chapter reports the complexities in managing English language teaching, involving teaching problem solving and communication skills in English.

Finally, Chapter 8 discusses the key findings that build knowledge and understanding of the complexities of teaching English within an engineering-based context and presents the implications for further research and for practice.

This chapter presented the background of the study, the statement of the problem, the aims of the study, the significance of the study and the thesis structure. The next chapter discusses and reviews the literature.

Chapter 2 Literature Review

Higher education institutions around the world play important roles in building human resources for the future workforce. Globalisation, however, makes it challenging for these higher education institutions to keep up with the changing professional demands of the workplace. In order to keep up with these changing demands, institutional goals will need to be constantly updated, and the curriculum, programme and courses will experience continuous changes. In Malaysia, for example, globalisation has changed the pattern of its economic trends, requiring expansion of industrial activities to international regions (Rostam, Jali, & Toriman, 2010). Therefore, it is crucial for higher education institutions in Malaysia to ensure that the future workforce is equipped with knowledge and skills that meet the demands of globalisation. This includes ensuring that graduates are able to demonstrate exceptional English language abilities. This creates challenges in English language teaching in higher education.

The first part of this chapter reviews research on the complexities of English language teaching in higher education. This contextualises the shift in English language teaching in higher education towards teaching English for Specific Purposes (ESP) which underpins this study. Literature on international research trends in ESP is also reviewed to highlight the need to teach English relevant to a specific discipline, specifically for engineering. It is argued that there is a need for research in the field of ESP from the perspective of English language teaching, focusing on the challenges for EL educators in teaching ESP courses, and in positioning themselves within a discipline specific context, such as in engineering.

The second part of this chapter reviews the literature on engineering education, particularly in Malaysia, raising issues within engineering education and the challenges in developing English language skills in Malaysian undergraduates. An initial section on the evolution of engineering as a field is included to contextualise the study and to provide a clearer picture of why these changes were required, and how these changes affect engineering education. Understanding this highlights the significance of the role of ESP programmes in engineering contexts. Next, the need for engineering education programmes to address the demands of engineering accreditation is discussed in terms of the impact of these processes in engineering programmes specifically in relation to how the engineering accreditation requirements frame the academic curriculum, and have transformed the nature of engineering education. The discussion identifies how the shift in focus in engineering education impacted teaching and learning in engineering classrooms, particularly on teaching problem solving and communication skills, and the use of English as the medium of instruction

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